

# The Anatomy of Kerckring's Valves

## Case Report on Their Maldevelopment \*

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THE DUTCH ANATOMIST Kerckring \*\* has been credited with the first authoritative description of the valves of the small intestine although their existence was known previously to Fallopio and probably to others. Kerckring's valves also known as the *valvulae conniventes* or as the *plicae circulares* rarely have been associated with pathology of the small intestine. Anatomic studies have demonstrated abnormalities such as irregular displacement, abnormal disposition and effacement of the valves but little consideration was given to their clinical significance. Brief surgical reports made many years ago have noted and correlated these maldevelopments or anomalies with unusual cases of intestinal occlusion or intraluminal bowel obstruction. The development of modern radiographic technics has established the configuration of Kerckring's valves, and alterations from the basic pattern have become essential in the elucidation of small bowel disease. An unusual case of maldevelopment of these valves directed our attention to this structure and resulted in the anatomic study presented in this report.

### Case Report

Clinical data abstracted from case 100641. A married 50-year-old white male was admitted to the surgical service with severe abdominal pain, nausea and vomiting. He had been sick for 3 days

prior to admission with colic and high temperature. At home, the family physician made a provisional diagnosis of perforated peptic ulcer advising immediate hospitalization which the patient delayed for almost 10 hours. On admission his rectal temperature was 102° F., pulse 94 and respirations 28 per minute. Hematologic findings were: Hemoglobin 16.0 gm.%, red cell count 5 million, white cell count 15,600 with 56% neutrophils, 37% bands and 7% small lymphocytes. Urinary findings were: specific gravity 1.030, albumin, sugar and acetone negative. On microscopic examination there were no casts but occasional clumps of white blood cells and red blood cells. There was generalized abdominal rigidity and marked rebound tenderness in the right lower quadrant. A painful mass in the cul-de-sac was palpable on rectal examination. Blood pressure was 110/80 mm. Hg. Posterior-anterior roentgenograms of the abdomen in the upright position showed no collections of free air under the diaphragm.

Exploratory laparotomy was performed through a right paramedian incision. After the peritoneal cavity was opened about 500 ml. of cloudy fluid was removed by aspiration. A moderately distended, thick-walled hemorrhagic section of ileum in the right lower abdomen was found adherent between loops of bowel. The former was covered with a purulent exudate. A small walled-off perforation was identified near the distal end of the diseased bowel about 20 cm. from the ileo-cecal valve. A section of intestine measuring almost 40 cm. was resected and an end-to-end anastomosis was performed.

The surgical specimen was examined during the operative procedure in consultation with the pathologist (Fig. 1). The excised bowel presented a congenital maldevelopment characterized by circular bands which encompassed the intestine at regular intervals about 3 cm. apart and divided it into sharply demarcated segments or sections. With the intestine open along its antimesenteric border the circular bands on the serosa were found to correspond with the internal placement of Kerckring's intestinal valves. In this specimen a total of 19 abnormally large valves were counted. Each of the latter projected into the lumen as a complete circular fold and reduced the intestinal

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\*\* Kerckring or Kerkring, Thomas Theodore (1640 to 1693) was a Dutch anatomist and physician. He described the intestinal valves in his principal publication *Spicilegium Anatomicum; Observation XXXIX*. He was also the first to describe the large ossicle sometimes present at the lambdoidal suture.

area by 50% or more. Intestinal dilatation was caused by a rigid stenotic valve against which was pressed an impacted bolus of food. The basic pathophysiology observed in this case was secondary to an intraluminal bowel obstruction. The serosa of the bowel was markedly congested and covered irregularly by a purulent exudate. A partially sealed perforation was demonstrable in close proximity to the stenotic valve. Microscopic sections through this region showed an absence of the intermediate layers of the intestinal wall suggestive of pseudo-diverticulosis but in this case co-existent with an anomalous fixed valve.

A careful exploration of the abdominal viscera was made. Examination of the bowel *in vivo* was greatly facilitated by transillumination with a Cameron light. Commencing with the jejunum at the ligament of Treitz and ending at the ileocecal valve the bowel was segmentally striped by circular serosal bands in the same manner as demonstrated in the excised specimen. Between the fingers was felt the membranous diaphragm of the valve which was soft and nonocclusive and distributed evenly through jejunum and ileum. The large intestine was examined in a similar manner but appeared normal on inspection and transillumination. There were no other congenital anomalies of the digestive system visible.

The postoperative course was satisfactory. Nutrition and electrolyte balance were maintained during 5 days of intestinal intubation after which recovery of gastro-intestinal function was complete and the patient was subsequently discharged. He has since returned to work as a plasterer and appears to be in good health. He notes that bowel evacuations occur twice daily. Previously constipation was a characteristic symptom. A recent x-ray series showed no sites of intestinal occlusion or retardation of passage of barium.

An anatomic examination was made of the valves of the small intestine removed from 42 adult cadavers and from ten full-term stillborn babies. The number of valves, size, distance between valves, type of valve and other relationships were studied.

Kerckring's valves are found in the small intestine only. Each valve consists of a reduplication of two folds of mucosa held in apposition (back to back) by submucosa. The free margin of the mucosal fold projects into the bowel lumen and receives blood vessels, lymphatics and nerves via the supporting submucosa. The intestinal valves appear first in the descending portion of the duodenum, are distributed

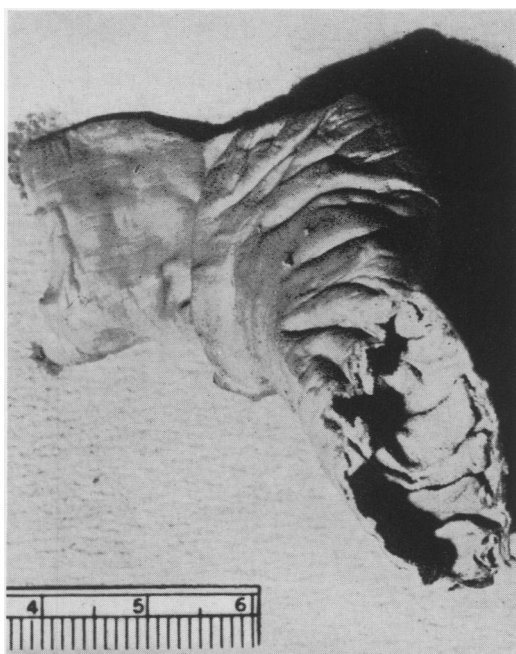


FIG. 1. Close-up photograph of the excised surgical specimen. The area shown is distal ileum, at a point approximately 20 cm. from the ileocecal valve, cut on a tangent so as to show a section of the intact lumen. The giant hypertrophy of the valves of Kerckring in the area with almost complete occlusion of the lumen is clearly visible.

throughout the entire jejunum and then gradually regress and disappear within the proximal two-thirds of the ileum. The distal ileum is usually devoid of valves and shows a smooth regular mucosal surface. According to the anatomists Cruveilhier, Luschka and Sappey the valves terminate abruptly within one meter of the ileocecal junction.<sup>4</sup> In seven specimens well formed valves were distributed throughout the entire ileum up to the junction with the cecum. Kazzander made a similar observation but stated that complete valvulization of the ileum was rare.<sup>4</sup>

Reports on the total number of intestinal valves have varied. In the present study, the values ranged from a minimum of 432 to a maximum of 936 valves. Sappey stated this average to be 900 valves.<sup>4</sup> In an interesting case study Mattei noted on autopsy examination an excess of 1,500 valves in the small intestine.<sup>3</sup> Kazzander obtained a count of 678 valves in the male and an

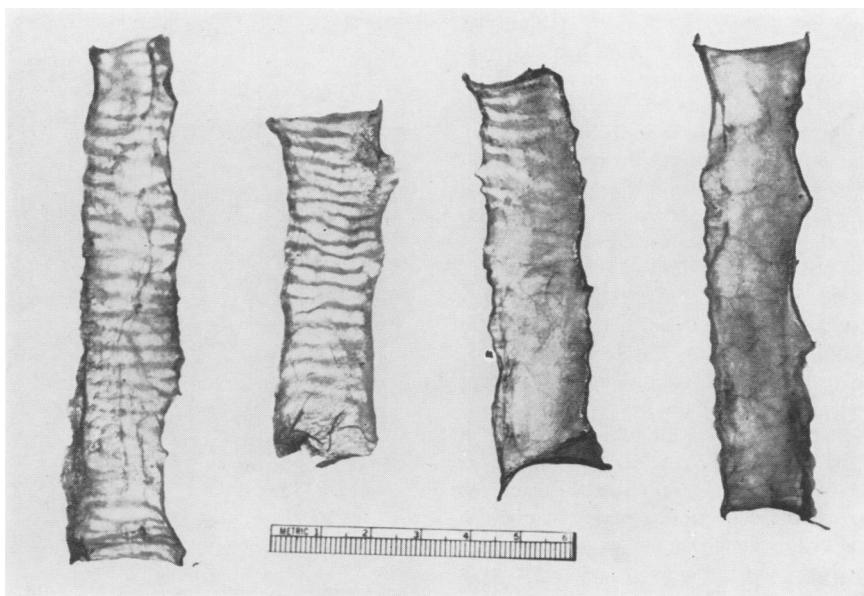


FIG. 2. Specimen of jejunum-ileum taken from stillborn infants. The sections were opened in the long axis of the small intestine at the antimesenteric border. They show segments of mucosa with complete absence of valves of Kerckring and other segments with only partial valvulization present.

average of 644 valves in the female.<sup>4</sup> A distinction or differentiation based on sex could not be established but there seemed to be a correlation between the length of

the small intestine and the number of valves.

Kerckring's valves attained their maximum development in the duodeno-jejunum

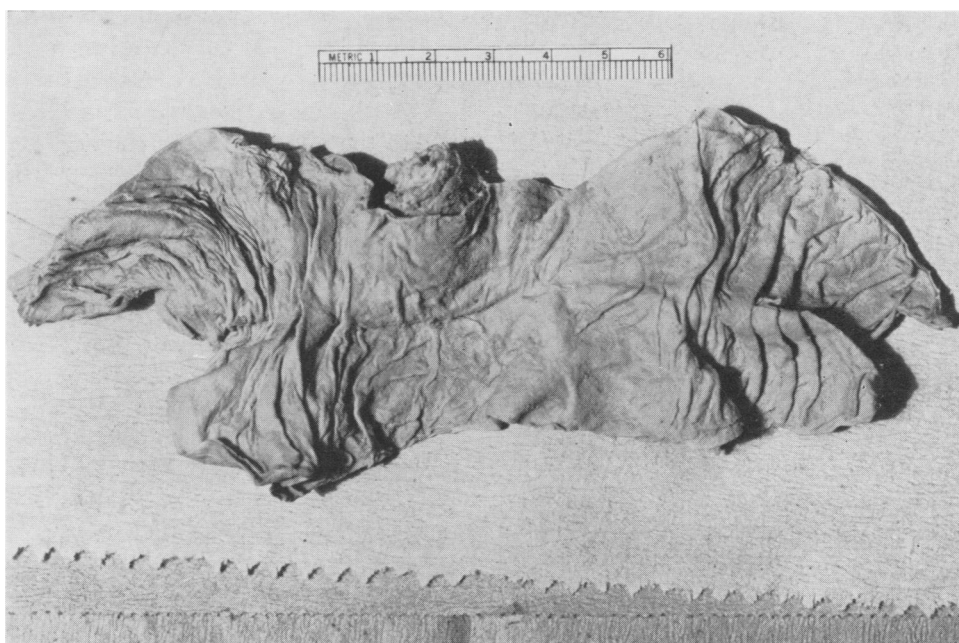


FIG. 3. Specimen of jejunum taken from an adult male cadaver. The section was opened along the antimesenteric border and shows an area of the mucosa which is devoid of valvulae.

where they reached a height of 4 mm. to almost 1.0 cm. In this region the valves were close together while the mucosal surface between valves (intervalvular space) averaged less than 3 mm. In the proximal two-thirds of the ileum the valves were variable in height, from 1 mm. to 6 mm. depending on their distance from the jejunum. In the ileum the intervalvular space increased progressively up to 9 mm. and thereafter remained as a flat mucosal surface. Sappey's values for the intervalvular space varied between 6 and 8 mm.<sup>4</sup> Dargein stripped the mucosa from the small intestine by a special technic and demonstrated that in the unfolded state it averaged ten to 14 meters in length whereas in the valvular state the mucosa was reduced in length to less than eight meters.<sup>1</sup>

Three types of intestinal valves can be identified: the circular valve, the spiral



FIG. 5. Cross-section of small bowel showing the intestinal valve (valve of Kerckring) projecting into lumen.

valve and the longitudinal valve. The circular valve may be partial or complete. The

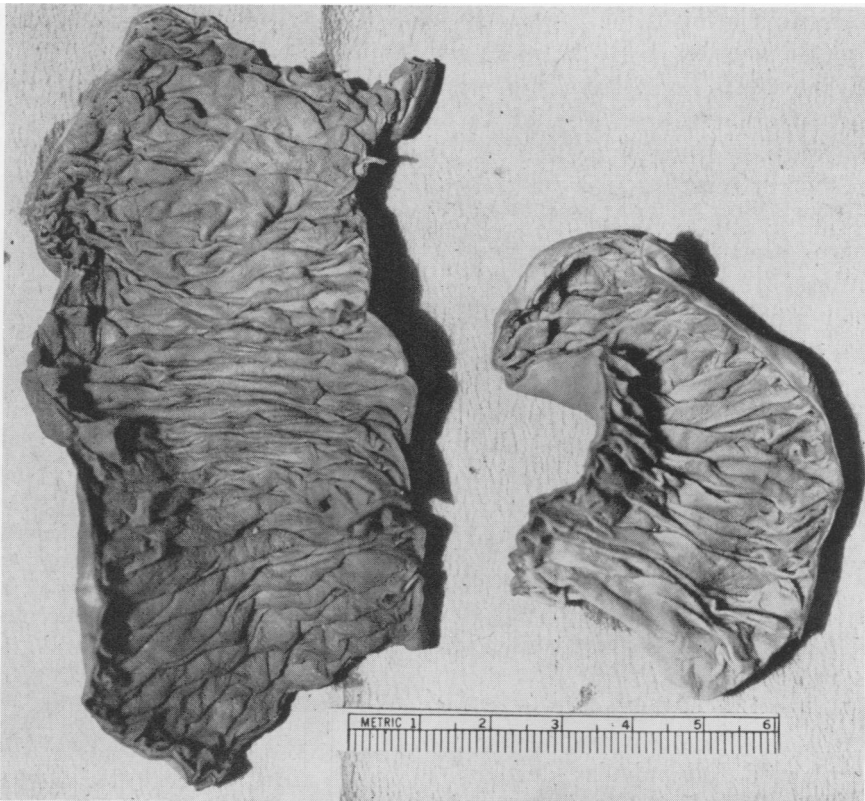


FIG. 4. Specimens of jejunum taken for comparison from an adult male cadaver. The sections were opened along the antimesenteric border and illustrate the normal configuration of the valves of Kerckring.

latter type arises from the mesenteric side and extends one-half to three-fourths of the way around the bowel. The fold or plica disappears when it reaches the antimesenteric side. Its projection into the intestinal lumen gives it a crescentic shape when viewed sagittally. The complete circular valve arises transversely from the entire inner circumference of the bowel and projects into the lumen like a round membrane or diaphragm. Regardless of form these valves are soft and nonocclusive but may become stenotic due to fibrous degeneration or malignant involvement. The circular crescent valve is the predominant type of valve. The complete circular valve is uncommon and is found usually as an occasional form interspersed among the crescentic valves or may be seen in anomalous conditions as described in this case report.

The spiral type of valve comprises two or more circular folds arranged like a helix. In our anatomic specimens the latter were few and varied from ten to 40 in number per small intestine. Longitudinal valves originate on the mesenteric side of the bowel and range up to one inch in length connecting two or more circular valves at their bases. The longitudinal valves are more numerous than the spiral valves; average 53 valves.

The small intestine of ten full-term still-month of embryologic development after the coats of the intestinal wall have been completely differentiated and the villi and the glands of Lieberkuhn have developed. Valvulization occurs in a proximo-distal direction with the rapid overgrowth of epithelium in the form of plicae into the primitive gut. Abnormal morphogenesis, unrestrained growth and desynchronized tubulization of the bowel may result in anomalies and occlusion.<sup>2</sup>

The small intestine of ten full-term still-born babies were carefully inspected. Four specimens showed full valvular development as described for the normal anatomy

of the intestinal valves. In three specimens Kerckring's valves were completely absent or had not yet developed. In the other three specimens isolated sections devoid of valves were found in the jejunum and proximal ileum. "Bare areas" similar to the latter were observed also in six adult specimens. These avalvular spaces varied in length from 3 to 10 cm. and showed a normal even mucosal surface without any signs of pathology in the bowel wall or in the mesentery. The intestine in immediate proximity to these bare areas exhibited the normal pattern of valvular arrangement.

Functionally, the valves retard the rapid propulsion of food through the small intestine and provide an increased digestive surface for absorption. In the normal state the intestinal valves when coated with barium produce a characteristic herring-bone type shadow on radiograms.

### Summary

1. An unusual case of intraluminal small bowel obstruction due to congenital maldevelopment of Kerckring's valves is presented.
2. The anatomy of the intestinal valves is discussed and the literature pertaining to these valves is reviewed.

### References

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